

Biol635/Math635/Biol432/Math430  
Fall 2020

Homework 2

Answer the following questions.

- Justify your answers.
- Explain your results.
- Provide the necessary calculations in a clear way.
- Provide the codes you used (if any).

**Question 1**

Calculate the equilibrium (reversal) potentials for the following ions at a temperature of 20° C.

- (a)  $K^+$ ,  $[K^+]_{out} = 5$  mmol/L,  $[K^+]_{in} = 150$  mmol/L.  
(b)  $Na^+$ ,  $[Na^+]_{out} = 150$  mmol/L,  $[Na^+]_{in} = 15$  mmol/L.  
(c)  $Cl^-$ ,  $[Cl^-]_{out} = 125$  mmol/L,  $[Cl^-]_{in} = 10$  mmol/L.  
(d)  $Ca^{2+}$ ,  $[Ca^{2+}]_{out} = 2$  mmol/L,  $[Ca^{2+}]_{in} = 0.0002$  mmol/L.

What is the effect of increasing the temperature to 25° C (room temperature) on these equilibrium potentials.

**Question 2**

Consider an ion  $X^+$  at 20° C. What is the concentration relation  $[X^+]_{out} / [X^+]_{in}$  necessary to maintain a resting membrane potential  $V = -60$  mV?

How is this value affected when the temperature is increased to 25° C?

### Question 3

Consider the following passive membrane equation

$$\tau \frac{dV}{dt} = -(V - E_L) + R I_{app} \quad (1)$$

with  $V(0) = E_L$ ,  $R = 100 \text{ M}\Omega$ ,  $C = 100 \text{ pF}$ ,  $I_{app} = 0.25 \text{ nA}$  and  $E_L = -60 \text{ mV}$ .

- (a) Calculate the value of  $\tau$ .
- (b) Calculate the value of the term  $R I_{app}$ .
- (c) Calculate, if possible, the time it takes the voltage to reach  $V = -50 \text{ mV}$ .
- (d) Calculate, if possible, the time it takes the voltage to reach  $V = -30 \text{ mV}$ .

### Question 4

Write a code to solve numerically eq. (1) or adapt the template code provided in the course website. Simulate eq. (1) for the parameter provided in Question 3.

Note: The axis should be labeled correctly and the fonts should be large enough (suggested: “fontsize” = 24).